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DISCOVERY OF CRETACEOUS AND OLDER TERTIARY STRATA IN MONGOLIA[1]

THE American Museum of Natural History announces,[1] under date of May 3, 1922, that strata of Cretaceous age, overlain by two distinct Tertiary formations, have been discovered in the Gobi region of southeastern Mongolia.

They were found on the outbound trip from Kalgan to Urga at a point about 260 miles northwest of Kalgan. Strata of Cretaceous age are wholly unknown in Eastern Asia, as far as the writers of the present communication are aware, and because of the apparent importance of the find, it was decided to leave the geologists in camp at this place while the rest of the party moved on. Accordingly Messrs. Berkey, Granger and Morris spent a week in additional inspection of the ground and furnish the notes for this memorandum.

Obretcheff, the Russian geologist, who gives an account of a reconnaissance trip over this same route from Ude to Kalgan, describes sedimentary beds at many places, always referring to them as representatives of the Gobi formation. His only age determination, however, was made on the basis of a few fragments of *Rhinoceros,* found at the escarpment five miles south of Iren. These remains were judged by Eduard Suess, to whom they were referred, to indicate an age not earlier than the Miocene. The Tertiary age of the rest of the occurrences mentioned by him seems to have been taken for granted and apparently that is in general correct, but it is evident that the Gobi formation can not properly include strata of both Tertiary and Cretaceous ages.

[1] Abstract: "Discovery of Cretaceous and Older Tertiary Strata in Mongolia," Walter Granger and Charles P. Berkey. American Museum *Novitates,* No. 42, 7 pp. 1 fig., August 7, 1922.

It is clear also that the term Gobi formation or Gobi series is properly applied to the Tertiary beds instead of to those of Cretaceous age.

The best exposures of this underlying Cretaceous formation are in the vicinity of the small salt marsh Iren Dabasu, where a total thickness of about 150 feet of nearly horizontal strata is judged to be of this age. Tertiary beds not older than the Miocene lie on top of the Cretaceous strata and are best exposed about five miles south of Iren. Twenty miles farther south early Tertiary beds were found in essentially the same relation.

The finding of this upper Cretaceous formation makes a new designation necessary. For this purpose nothing seems to be as appropriate as the name of this locality. We therefore propose the term "Iren Dabasu formation" for these beds.

Remains in all three beds are fragmentary, decidedly so in the Houldjin gravels, but they are of unusual interest apparently and we have taken everything which has any character.

Dinosaurs are represented in the Iren Dabasu beds by one complete tibia, ends of femora and humeri, presacral and caudal centra, many good foot bones, including claws of fore and hind feet, portions of a small carnivorous dinosaur skull with two or three teeth, and two teeth of a predentate, as well as two portions of jaw with the alveoli of some teeth, also predentate. Remains of the small *Ornithomimus*-like creature are particularly abundant and the last day at Iren Dabasu we picked up probably fifty good foot bones and centra from two or three knolls. We could find no teeth of the little fellow though—wonder if he was edentate like *Struthiomimus?* The Cretaceous exposures are very limited so far as we could see but may, of course, outcrop in other basins to the east or west of the road. We did not have time to extend our work in either direction. The outcrops we did see will stand a more careful going over.

The Houldjin gravels are exposed as a rather thin capping to a low bench of Cretaceous which we followed for several miles. Things are badly broken up here—even such massive bones as the heads of femora and humeri were usually cracked into several pieces before deposition. There is one fine bone—a calcaneum of the big beast which would be a match for the astragalus of *Baluchitherium*[2] (?). I can think of nothing else to which it might belong. It is as long as the great *Megatherium* calcaneum from Long Branch, N. J., but is not edentate. A head of a femur is the size of one's head and other limb bone ends correspond. Some enormous rhinoceros teeth (broken) may belong with this animal. Smaller teeth are surely *Rhinoceros.* We did not explore the full length of the exposure and there are possibilities in excavation at one or two points of the bluff where we did explore.

The Irdin Manha beds offer the greatest opportunity for future work. Mammalian remains are abundant though fragmentary and we examined less than two miles of a line of exposures extending many miles both east and west of the trail. A small lophiodont (*Helaletes*-like) is most abundant and we got numerous teeth besides two maxillæ (one with premaxilla and orbital region) and a few lower jaws, also numerous foot bones, limb bones and vertebræ. Next in abundance is a perissodactyl, looking much like our late Eocene titanotheres. We have several premolars, many incomplete molars and one lower jaw with p_3—m_3 in fair condition. Other forms are curiously rare, a creodont lower jaw and an artiodactyl astragalus or two being the only things noted. Trionychids are common and we saw a complete though badly broken carapace which we were hurrying to get to our car before a storm overtook us the last day we were there. We made three trips down from Iren Dabasu camp but could not do more as our food was getting short and we had to join the rest of the party here.

In the vicinity of the small salt lake Iren Dabasu, the Cretaceous beds lie immediately on the slate floor of the basin and between this base and the first determinable beds of later age, in this case late Tertiary, about 150 feet of strata are exposed. The bottom members are dominantly sands and sandstones, prevailingly thin-bedded, some of which are strongly

[2] A gigantic perissodactyl described by C. Forster Cooper from Baluchistan.

cross-bedded and well cemented. The middle members become finer grained, more mixed with clay and more variable in color. The upper beds are dominantly clays and sandy clays and very fine sands, varying in color from white to dark red and drab and yellowish green. No less than twenty distinct beds or layers can thus be distinguished, all of which are regarded as belonging to a single geologic formation.

Only the lower members of this "Iren Dabasu" formation have been found to be fossiliferous. The list includes:

1. Predentate dinosaurs, probably of the bipedal type.
2. Carnivorous dinosaurs of at least two genera, the smaller one being of the *Ornithomimus* type.
3. Crocodiles.
4. Turtles of the *Trionyx* type.
5. A few pelecypod shells.

The geologic column for the Iren Dabasu basin therefore is essentially as in the following table:

Recent	Uplift and Erosion			
	Peneplanation			
Tertiary	Miocene or Later: Upper barren sands, Rhinoceros gravels	25′+ 5′	The Houldjin Formation	The Gobi Series
	Oligocene or Eocene: Upper barren sandstones, The Lophiodont bed	25′+ 4′	The Irdin Manha Formation	
	Physical and Faunal Break			
Cretaceous	Upper barren members, chiefly clays, marls and fine sands	90′	The Iren Dabasu Formation	
	Lower or Dinosaur beds, chiefly sands and sandstones	60′		
	Great unconformity			
Pre-Cretaceous	The old-rock floor, chiefly slates, limestones and igneous rocks			Probably The Nankon Series

THE HOULDJIN BEDS (MIDDLE TERTIARY)

For the late Tertiary beds found five miles farther south and belonging to the Gobi Series of Obretcheff we propose the term "Houldjin Beds," taken from the local name of the upland formed by these beds. They are characterized by the following fossil content:

1. A rhinocerid.
2. A large carnivore.
3. An artiodactyl of the size of a Virginia deer.
4. An enormous mammal, probably a perissodactyl and possibly related to or identical with *Baluchitherium*, discovered by Forster Cooper in Baluchistan.
5. A tortoise of large size.

There is a sharp physical change immediately below this formation and only the coarse sandy conglomeratic member at the very base has been found to be fossiliferous. The fossil remains are unusually fragmentary.

IRDIN MANHA FORMATION (EARLY TERTIARY)

For the early Tertiary beds found twenty-five miles farther south, also assumed properly to belong to Obretcheff's Gobi Series, we propose to use the term "Irdin Manha formation." It appears to lie immediately on Cretaceous beds, the Iren Dabasu formation, and again there is a sharp change in type of rock. The beds are cross-bedded sandstones, limy sands and pebbly sandstones. Only the lower member has been found to be fossil-bearing. It is characterized by the following forms: (1) Small Lophiodonta of at least two species in great abundance; (2) A perissodactyl about the size of the Upper Eocene titanotheres and possibly related to this family; (3) A small artiodactyl; (4) A small creodont; (5) An abundance of turtles of both the hard-shelled and soft-shelled groups; (6) Teleost fishes.

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THE FEEDING POWER OF PLANTS[1]

DIFFERENT species of plants vary greatly in their feeding power or ability to secure the required elements from the natural mineral matter of the soil or from difficultly soluble phosphate and potash minerals which may be applied as fertilizers. The character of the native vegetation is in many cases determined partly by differences in the feeding power of plants. Of the cultivated plants it is well known that buckwheat will feed much more strongly on rock phosphate than corn. The subject is thus not only of scientific interest but also of great practical importance.

It was formerly believed that the mineral matter of soils was made soluble and available to plants through the action of various acids excreted by the plant roots. Later experiments, especially those by Czapex, indicated that, other than carbonic acid, plants normally excrete at the most only minute quantities of acids. As is now well known practically all plants excrete through their roots large quantities of carbonic acid. Attempts to explain differences in feeding power on the basis of differences in amount of carbonic acid excreted have not been successful.

It might, however, still be argued that it is not necessary for plants to actually give off or excrete the acids in measurable amounts in order that they exercise an influence on the solution of mineral matter; it might be argued that all that is necessary is for the acids to saturate completely the walls of the root hairs which come in intimate contact with the mineral particles. That this is not the correct explanation is evident from what follows.

During recent years, by aid of the hydrogen electrode much valuable information has been secured regarding the acidity of plant juices.[2] This information is aiding greatly to clarify our conception regarding the feeding power of plants and the relation of plant growth to soil acidity and alkalinity. It indicates that the excretion of other acids than carbonic or mere presence of them in the walls of the root hairs is not an important factor in the feeding power of plants, for it is now known that a plant with a nearly neutral sap may feed more strongly on relatively insoluble minerals than one with a decidedly acid sap; *e. g.*, sweet clover and alfalfa with relatively slightly acid root saps of p_H 6 to 7 feed more strongly on feldspar than buckwheat with a relatively strongly acid root sap of p_H 4 to 5. If plants made the mineral matter of soils available through the excretion or presence of acids other than carbonic, then the reverse should be true, that is, the buckwheat should feed more strongly on feldspar than alfalfa and sweet clover because it would excrete or have present much the strongest acid. Similarly corn with a more acid sap than either alfalfa or sweet clover should feed more strongly than the other two on rock phosphate and feldspar if it were a matter of excretion or presence of acids, but again the opposite holds true. Undoubtedly, if data for more species of plants were available many more cases of this kind could be cited.

It is therefore necessary to find some other explanation for certain differences in feeding power than those thus far given, for evidently there are other factors than the excretion of acids which exercise a controlling influence on the feeding power of plants. A number of years ago the writer presented a new theory[3] regarding the feeding power of plants in which the feeding power for rock phosphate was explained on the basis of the law of mass action and chemical equilibrium. The reaction making the phosphorus of rock phosphate available to plants is one between carbonic acid and the tricalcium phosphate in rock phosphate which may be represented as follows:

$$Ca_3(PO)_2 + 2H_2CO_3 \rightleftarrows Ca_2H_2(PO_4)_2 + CaH_2(CO_3)_2.$$

[1] Published with the permission of the director of the Wisconsin Agricultural Experiment Station.

[2] Truog, E., and Meacham, M. R., *Soil Science*, 7, (1919), pp. 469-474; Clevenger, C. B., *Soil Science*, 8, (1919), 217-242; Bryan, O. C., *Soil* Science, 13, (1922), 271-302; Bauer, F. C., and Haas, A. R. C., *Soil Science*, 13, (1922), pp. 461-477.

[3] SCIENCE, N. S., 41, (1915), pp. 616-618; *Research Bulletin 41*, 1918, Wis. Agr. Expt. Sta.

In order that this reaction continue indefinitely, it is necessary that both products of the reaction be removed in somewhat the proportion that they are produced. This is the condition that actually exists with plants like buckwheat and sweet clover which use a large amount of calcium. They are thus enabled to feed strongly on rock phosphate, as is found by experiment. In case the calcium content of a plant is low, and the calcium bicarbonate is not removed in as high a proportion as the soluble phosphate, the rate of solution of the phosphate becomes slower and slower with time and thus the plant is unable to feed advantageously on the rock phosphate. This is the case with plants like oats and corn which have a low calcium content.

This theory may be tested in other ways; *e. g.*, the immediate availability of rock phosphate to plants like corn is much greater on acid soils than on the non-acid ones. This is due to the removal and precipitation of the calcium bicarbonate from solution by the soil acids. The effect on the availability of the phosphate is the same as though the calcium bicarbonate were removed by the plant. Working with quartz cultures, Bauer[4] has shown that the availability of rock phosphate to corn may be increased by leaching the cultures occasionally. This leaching removes the excess of soluble calcium bicarbonate and the effect is again the same as though it were removed by the plant. The addition of ammonium salts has also been found to increase the availability of rock phosphate. This is at least partly due to the effect of ammonium salts in increasing the solubility of calcium bicarbonate, which has the same effect up to a certain point as is produced by removing the calcium bicarbonate.

There is no question but what the application of the law of mass action to a study of the conditions of solution of mineral matter around the plant roots makes possible a correct explanation of many differences in the feeding power of plants. The conditions necessary for the continued solution of mineral matter in which two soluble products are formed at the feeding points of roots are explained by this means. When only one soluble product is formed as is the case in the solution of phosphorus from iron and aluminum phosphate by hydrolysis and the solution of potassium from orthoclase feldspar by either hydrolysis or carbonation, and in fact the solution of most bases from the silicates of the soil, differences in the feeding power of plants for these are not explained directly by the foregoing principle. The reaction of these minerals with the solvent at the feeding points of roots may be represented as follows:

$$FePO_4 + 3H_2O \rightleftarrows Fe(OH)_3 + H_3PO_4.$$

$$2KAlSi_3O_8 + H_2CO_3 + H_2O \rightleftarrows H_4Al_2Si_2O_9 + 4SiO_2 + K_2CO_3.$$

In both of the reactions only the last product is soluble and hence is the only product that can be removed either by the plant or in any other way. The conditions of solution are thus the same for all plants since water and carbonic acid are present in all cases. Differences in the feeding power of plants for the essential elements of these compounds must, therefore, be due to differences in conditions in the interior of the plants where the elements are actually used by being precipitated out of solution to form an essential part of plant compounds, making it possible for some plants to utilize more completely the elements from dilute solutions than others. In other words some plants can get along with more dilute solutions of certain elements than others.

The discussion in this connection will be limited to the base-forming elements. These elements are used by plants largely for at least three rather distinct purposes: (1) They are precipitated or held in physical and chemical combination with important colloidal plant compounds or complexes of which they may form an essential part. (2) In the form of the carbonate or bicarbonate they are used for the regulation of the reaction of plant proteins and other compounds, the plant sap, and precipitation of acids like oxalic out of solution. (3) They may act as carriers of acid forming elements. Potassium is used largely for the first purpose. Calcium is used for both the first and second purpose. Some

[4] *Soil Science*, 9, (1920), pp. 235-247.

plants, for example, the cultivated legumes, many of the cruciferæ, and buckwheat, require large amounts of calcium, much of which is probably used for the second purpose. Magnesium is probably used to a considerable extent for the third purpose as a carrier of phosphorus. Calcium and potassium may, of course, also be used for the third purpose, but it is only with the first two purposes that the present discussion is concerned.

In connection with the first purpose it is important to consider the following: There are always at least two important factors which determine how completely an element may be precipitated out of solution; viz., the reaction of the solution and the solubility of the precipitate formed. A proper regulation of the reaction is the most important factor in many precipitation processes. As a rule base-forming elements are more completely precipitated from a slightly acid or neutral solution than from a more acid one.

On this basis plants with a slightly acid or neutral sap especially of the leaves where the most active processes take place should be able to utilize potassium advantageously from a more dilute solution and feed more strongly on a slightly soluble potash mineral like feldspar than those plants with a more strongly acid sap, providing the reaction of the nutrient solution is favorable for the plants. Although the data available along this line are very meager, an examination of what there are indicates that this is actually the case. The sap of sweet clover leaves[5] ranges from slightly acid to slightly alkaline. Of the data known to the writer this is the only case in which the sap is sometimes alkaline. Theoretically the plant should feed strongly on the potash in feldspar and in actual test with quartz cultures Bauer[6] found it able to make a normal growth when forced to obtain all of its potash from feldspar. Of the common agricultural plants for which there are data available buckwheat has the most strongly acid sap of any in the leaves and it feeds very poorly on feldspar as should theoretically be the case. In tests with quartz cultures the writer found that alfalfa and sweet clover can obtain the necessary potassium for normal growth from more dilute solutions than corn and buckwheat which have a more acid sap. Much more data are needed before conclusions can be made definitely for all cases. The available data indicate strikingly the importance of the internal acidity on the feeding power of plants for potassium.

What has just been said in regard to potassium applies only when the nutrient or soil solution has a reaction which is favorable for the plant. If the nutrient solution is distinctly more acid than the plant sap, it will tend to make the plant sap more acid and the situation in regard to feeding for potassium may be greatly disturbed. In this connection it should be noted that alfalfa and sweet clover require relatively large amounts of potassium and quickly suffer from a lack of it, if the even dilute required concentration in the soil solution is not maintained due to a lack of the relatively insoluble potash minerals.

Undoubtedly the solubility of the potassium compounds formed in different plants is also a factor in the feeding power, but it seems reasonable to believe that to some extent the potassium compounds in different plants are similar and hence have somewhat similar solubilities. The solubility factor, therefore, because of its greater probable uniformity would not cause as great differences in the feeding power as the internal acidity factor which varies a great deal.

The relation of the feeding power of a plant for calcium which is to be used for the first purpose stated, to the acidity of the plant sap is probably the same as in the case of potassium. The amount of calcium required for the first purpose is, however, usually relatively small and the amount present in the soil solution relatively large so that the use of calcium for the first purpose is not a critical factor in the feeding power of a plant for calcium.

When plants use high amounts of calcium, the major portion is probably often used for the second purpose previously stated. The feeding power of a plant for calcium for this purpose seems to be related to the acidity of the plant sap, but the relation, as theoretically should be the case, is opposite to what it is

[5] Haas, A. R. C.: *Soil Science*, 9, (1920), pp. 341-368.

[6] *Soil Science*, 12, (1921), pp. 21-41.

with potassium, as is evident from the following: The reaction of the sap of different common agricultural plants has a range of p_H 4 to 8. This range is practically the same as that of the soil solution[7] in the humid region. It thus appears that plants through adaptation have come to have somewhat the same reaction as the medium on which they grow. It is well known that plants growing in solution cultures of unfavorable reaction tend to change the reaction of the culture to a more favorable one which is usually near that of the reaction of the plant itself. The plant does this[8] by utilizing a larger proportion of the acidic or basic constituents of the nutrient medium as the case may be. This again follows from the law of mass action, and the composition of the plant is thereby somewhat altered. Because of the highly buffered condition of the soil, plants can not materialy change its reaction in the way a solution culture is changed.

The unfavorable situation of a plant like alfalfa with a sap reaction of p_H 6 growing on a soil with a soil solution reaction of p_H 5 is thus apparent. This plant requires large amounts of basic material for the second purpose. How can it obtain this basic material for this purpose from a solution or medium which is ten times as acid as its own sap and system? It can not do it advantageously and hence the growth is slow and the content of basic material in the plant becomes lower than normal and even the reaction of the sap may become more acid than is normally the case. In extreme cases the plant not only grows slowly but also becomes sickly in appearance and easily succumbs to unfavorable weather conditions or parasitic diseases.

The buckwheat plant also requires a large amount of basic material. In fact, at the blooming stage it has a higher content of calcium than alfalfa, and yet it grows well on acid soils. The explanation of this is found in the high acidity of its sap, namely p_H 4 to 5. It can thus utilize advantageously a soil solution of p_H 5 as a source of basic material for the partial neutralization and regulation of its own sap and system.

The feeding power of a plant for calcium which is to be used for the second purpose is dependent largely on the normal acidity of the plant sap. The more acid the plant sap the more advantageously can the plant compete with another system—the soil and its solution, for neutralizing material which is largely lime in the case of plants and soils. Plants like oats and corn have a low content of calcium and probably use most of it for the first purpose. They apparently do not produce much acid which needs to be neutralized. Their sap is normally quite acid. They are thus well able to get all the calcium they need from even quite acid soils. The opposite relation of the acidity of the plant sap to the feeding power of many plants for calcium and potassium is now apparent. A high acidity means a low feeding power for potassium in dilute solution and a high feeding power for calcium needed for the neutralization and precipitation of acids.

The nature of the injurious or toxic action of acid and alkali soils on plants is also apparent. Theoretically the nutrient solution most favorably adapted to a plant as regards reaction would be one with a reaction the same as that of the plant sap. In case the plant needed a large amount of calcium and other basic elements, a nutrient solution slightly more alkaline than the plant sap would probably be best. When the nutrient solution is more acid than the plant sap, the plant by mass action is forced to utilize acid forming elements in greater proportion than is normally the case and as a result the composition of the plant is changed giving one with less than the normal amount of basic material. If the nutrient solution is much more acid than the plant sap the solid material of the plant due to lack of bases becomes so much more acid than is normally the case, that the plant sap also becomes more acid. The change in reaction of the whole plant system greatly interferes with the normal plant processes and as a result the plant grows slowly, becomes sickly and may even die. If a plant growing in a nutrient solution of favorable reaction were transferred to one with a much more acid reaction there

[7] Truog, E., *Soil Science*, 5, (1918), pp. 169-195.

[8] Hoagland, D. R., SCIENCE, N. S., 48, (1918), 422-425.

would undoubtedly follow an abstraction of basic elements from the plant compounds by the nutrient solution, and if the change were great enough, the plant would be killed.

In this connection it should be noted that the soil solution of acid soils often contains more calcium than the soil solution of less acid or neutral soils, and yet plants like alfalfa may suffer for lack of calcium in the former case and not in the latter, due to the fact that the acidity makes the calcium less available for certain purposes even though it is in solution. Availability is thus not only a question of solubility. It also depends on the form in which an element exists in solution.

SUMMARY

1. Differences in the feeding power of common agricultural plants for the essential elements of comparatively insoluble minerals are not due primarily to differences in amounts or kinds of acids excreted. The differences are due to several factors, some of which are concerned with external equilibrium conditions around the feeding roots, and others with internal equilibrium conditions inside the plant where the elements are actually used.

2. In case two soluble products are formed in the feeding region of the roots due to the action of carbonic acid on a mineral as is the case with rock phosphate, the feeding power follows the law of mass action and chemical equilibrium, being dependent on the removal of both of the soluble products either by the plant or partly by the plant and partly in other ways; thus plants with a high content of calcium feed strongly on rock phosphate because they remove both the soluble phosphate and soluble calcium bicarbonate in proper proportion.

3. If only one soluble product is formed as is the case with feldspar, the feeding power of the plant for the potassium depends on its ability to utilize potassium from a dilute solution which in turn depends largely on the acidity of the plant sap; the less acid the sap the greater the ability of the plant to utilize potassium from this source due to the fact that potassium is more easily and completely precipitated in the form of plant compounds in the less acid sap.

4. The feeding power of a plant for calcium which is used for the regulation of the reaction of the plant sap and colloidal system, and precipitation of acids, or for other elements used for these purposes, is also dependent upon the reaction of the plant sap but the relation is opposite to that of potassium; the more acid the plant sap the more easily can the plant compete with another acid system—the soil solution of an acid soil, for needed basic material.

5. In the case of base forming elements used for other purposes than regulation of the reaction and precipitation of acids, the relation of the feeding power for these to the plant sap is perhaps the same as for potassium.

6. There are undoubtedly many other factors which affect the feeding power of a plant but it seems that the ones given often exercise a controlling influence.

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THE TEACHING OF EVOLUTION

EVERY student, teacher and research worker in various fields of science must find cause for sincere regret in any attitude or movement that would limit the search for knowledge, or the presentation of scientific fact in the class room. There certainly is such a menace in the suggested limitation or elimination of the teaching of "evolution." It seems rather strange that such a conflict should be staged in a century made notable by outstanding advance in both pure and applied science. At no previous time have all men profited as much by the efforts of scientific workers. Then why such a hubbub about the teaching of what many think a fundamental concept of biological science?

The trouble seemingly was started by a group of conscientious folk who saw a sharp variance between their beliefs, religious or otherwise, and the theories presented and vigorously promulgated by many teachers. Some prominent men, as Mr. W. J. Bryan, made the matter one for public discussion, and the controlling trustees of certain schools requested or demanded that the doctrine of evo-

lution should not be taught in the institutions under their control. The question has been taken to the legislatures of two or three states with a near approach to tragedy to scientific work. In a brief and somewhat generalized form this is the history of the case through the past few months.

As is usual in such cases, as has been true throughout the conflict between scientific and religious men, this difficulty has arisen through gross ignorance, useless misunderstanding and thoughtless intolerance. We have not found any prominent scientists among the opposers of the teaching of evolution. From the vague and inconsistent references to the meaning of evolution and the subject matter of courses in which it is involved it hardly seems possible that the opponents of this teaching have had the most elementary training in the ways of science or have had any sort of open-eyed contact with the world about them. It is always dangerous to take any difficult or abstruse question to any average legislative body —and it becomes especially dangerous when the real issue is hidden in a mist of ignorance and misconception as in the case in review. Legislators must hear the majority of the people —not judge the truth of scientific theory nor establish the rectitude of religious belief. Such misunderstandings with more or less serious disturbance are wholly unnecessary, and would never arise but for unwarranted provocative aggression by one or both parties in the case.

We know one man well, who through twenty years of teaching in high school and college has never had reason to think of his biological training and religious beliefs as conflicting. He has been able to maintain perfectly harmonious relations with different leading Protestant churches, and no question as to his religious uprightness or sincerity has ever been raised. He has had a fair training in biological science and has touched the general field of science enough to understand the lines of harmony and possible variance as touching common or popular beliefs. Doubtless, many other men have had a similar experience of freedom from conflict between their religious, social and scientific work. It is easy to see how all things scientific may seem strange and often unbelievable to the man who has no scientific training or but very meager training and that of doubtful accuracy, and how theories or even facts carelessly or inaccurately stated so as to seemingly conflict with as deep-seated a thing as a religious belief would be cast out as unbelievable or heretical by such sincere folks. It must be remembered as a scientific fact that a great many people, probably a majority of Americans as well as of other folks, actually live and die by their religion, shaping social, financial, political, and moral decisions of each day and year by their religious beliefs. Scientists who will accept at once the newest and most far-fetched theory sometimes fail to take into consideration the fact just mentioned, even though the acceptance of the most important scientific teaching depends upon the attitude of the teacher toward that fact. That the untrained cannot understand the scientist's point of view is taken for granted. Is it asking too much of the scientist to expect him to take such a sympathetic attitude toward churchmen as he expects them to take toward himself? As much of the present difficulty has arisen through a failure of some who call themselves scientists to make themselves fully acquainted with the ideas of the people they would teach as through the "misguided reformers" who do not at all understand the theories they think they must oppose.

There has appeared an alarming amount of bigotry on the part of some who proclaim themselves the champions of science. The really desirable thing, after all, is the freedom for scientists to pursue their lines of research and constructive work, and on the part of others a feeling of trust that our scientific men are really doing something worth while instead of merely spinning useless or even dangerous theories. The attitude of the opponents of evolution does not seem to lead toward this desirable end; and some of the scientific men of the country have not been conciliatory in their remarks when discussing the question.

The chief cause for disagreement was stated clearly by Mr. Bryan (Quoted in SCIENCE,

March 3, 1922, pp. 242, 243.) in these words: "Christians do not dispute the right of any teacher to be agnostic or atheistic, but Christians do deny the right of agnostics and atheists to use the public school as a forum for the teaching of their doctrines." Some scientists through half a century with rapidly increasing boldness have made themselves critics of religious beliefs, holding in complete disdain the opinions of churchmen, without themselves entering experimentally into the merits of the case. There really seems but little reason for a scientist thinking himself fully fitted to discuss at any length the beliefs of a non-scientifically trained man unless the latter is at the same time given full right to discuss the opinions of the former. To put the matter bluntly—both are dealing with subjects entirely out of their field and about which they are, in most cases, essentially ignorant.

The grievance, from the viewpoint of the churchman, has been increased and in some cases made unbearable by the type of biological teaching found in many high schools. The responsibility for the recent difficulties may be largely traced to this cause in all probability. Among the first things impressed upon the college freshmen in natural science courses is the infallibility of a theory of evolution. This is usually made impressive by indefinite, incomplete or inaccurate illustrations with reference to the origin of man. The thorough student of biology soon finds himself facing other theories of evolution, and later forms a proper valuation of these theories with respect to the evidences in fact upon which they are founded. We have met with senior and graduate students, however, in college and university departments of biology, in whose minds the theoretical phases of evolution completely overshadow the basic facts, whose whole conception of Darwinism is included in the descent of man from monkey. Churchmen are not to be blamed for objecting to the promulgation of such ideas. Any right minded man should strenuously oppose such a program, and scientists ought to blush for shame at such a crude presentation of the story of organic development.

The teaching of science, particularly of biology or related subjects, in the high school is the chief area of stress, the place where misunderstandings may most readily occur. Here the teacher is usually to blame, albeit unintentionally so in many instances. Most of the high-school teachers of botany, zoology and biology are drawn from among those students who have spent a year or less in such classes in college and who try to pass on to their students the ideas presented in those elementary courses. It is small reason for wonder that the ideas of evolution caught on the wing in brief lecture periods, unsupported by wide reading and undigested by extensive laboratory work and field observation, should be inaccurate, calculated to rouse protest in any community. It certainly seems that in the interest of public support of true scientific work, such teachers should be kept from service. Under present conditions of school organization this is impossible, but changes in the organization and emphasis in elementary biology courses in colleges would materially lessen the harm from this source.

The elementary courses in college and university courses taken as electives to fulfill general requirements in science are also dangerous, turning out as they do thousands of young folks with but a momentary view of limited phases of biology. But behind all this is a warped view of the relative importance of facts and theories on the part of college and university instructors. After all is said a theory of evolution is but a theory. Which particular line of procedure has produced new forms of life in the past is a basis for discussion and disagreement among the most learned. However much we may respect the theory, however well it may be supported by accumulations of facts, it is subject to adjustment or even serious modification with the presentation of every new fact, and is liable to more or less rough handling by some new Darwin, Lamarck, or DeVries, as some older theories have been shaken by an Einstein. Certainly a theory of evolution suffers violence at the hands of any one who presents it as anything other than a theory. The idea of orderly development, which is all the term evolution may rightly include, will very, very rare-

ly arouse antagonism or even doubt. Danger comes with the presentation and insistence upon the claims of some particular type of evolution.

It should be said plainly that there are abundant unquestioned facts upon which our theories are based, and while we may differ in our opinions as to the significance of those facts, they are generally accepted. Variation of individuals of species or race, reproduction of like forms, the struggle for existence, the adaptation of organism and environment through the cutting off of the unfit, the production of new forms by hybridization, all these are facts of everyday experience, facts that may be taught without raising questions as to the teacher's religious views, facts which if more clearly and consistently taught would tend to develop a better trained group of scientific workers, teachers and general citizenry.

From the standpoint of right and wrong the teacher in college or elsewhere can not more justly force his theories upon an unwilling or unsuspecting public than can a religious enthusiast require all men to subscribe to his beliefs. The quack doctor, the religious fanatic, and the poorly balanced teacher of science are similar in that they are alike dangerous, and the general public should consider all with suspicion. Lampooning earnest religious folks because they refuse to accept all that comes to them in the name of science will not help to develop the very desirable discrimination between the true and the false, but will rather arouse more vigorous antagonism. There is no fundamental basis for conflict between enlightened and sincere churchmen and true scientists. The development of American institutions and ideals and the advancement of the material welfare of the American people have come from the efforts alike of churchmen, statesmen and scientists; and for continued prosperity, it is essential that there be harmony of purpose between these factors. It is the business of the leaders of scientific work and teachers of science to make such a discrimination between fact and theory that all must respect their findings, and to use such care in the presentation of subject matter that no one idea will be given the undue prominence that is provocative of misunderstanding and distrust. Why not make it quite clear that "Darwinism," whatever that may mean to the individual professor, is not all of evolution? Why not spend more time making clear to college students the facts of observation and experiment upon which the "Origin of Species" was founded? We are confident that more teaching of fundamental facts will lead to a better understanding between scientists and the rest of the world, and to a more hearty support of scientific endeavor.

F. L. PICKETT
STATE COLLEGE OF WASHINGTON

SCIENTIFIC EVENTS

VITAL STATISTICS OF GERMAN CITIES[1]

ACCORDING to official publications, the population of the 343 larger cities from which reports are accessible had increased one million, being 25,700,000 in 1921, as compared with 24,700,000 in 1920. It is evident, therefore, that 41 per cent. of the total population of the empire resides in these 343 cities. This remarkable growth of the cities is doubtless due, to a considerable extent, to the influx from the smaller towns and to the immigration from foreign countries. The number of living infants born in these cities was 560,000, or 21.8 per thousand of population, which denoted a falling off when contrasted with the record for the previous year, which was 23.8 per thousand. Since it has been found that economic factors exert a great influence on the birth rate, Dr. Roesle, taking the value of the mark in relation to the American dollar as a basis, has been making a critical investigation of the possible effect of economic conditions. In order to discover the influence on the varying birth rate throughout the twelve months of the year, it is quite evidently necessary to date back nine months the birth rate for each month, since in this manner the month in which the children were conceived is ascertained. In 1921, the birth rate of the urban population continued to drop until August, or, taking the

[1] From the *Journal* of the American Medical Association.

month of conception, back to November, 1920, in which month not only the value of the American dollar in marks but also the wholesale prices of German goods thereby affected reached the maximum of the observation period. Roesle therefore assumes that the failure of the rational increase in the birth rate for July, 1921 (conception month, October, 1920), to materialize is traceable to the further increase in the cost of living which followed the advance of the dollar and of the wholesale prices of German goods. In the months of February and March, 1921, the cost of living came down, and it is to be noted that there was a corresponding increase in the birth rate for the months of November and December, 1921 (just nine months later). It could not be shown that economic conditions exerted a perceptible influence on the death rate. The year 1921 shows the lowest recorded death rate in German cities with more than 15,000 inhabitants; namely, 13.5 per thousand of population, and excluding deaths among strangers and transients, the death rate was only 11.9. A comparison of the monthly death rates for former years brings out the fact that during the winter months of January, February and March, 1921, especially favorable weather conditions must have prevailed. The abnormally mild winter was followed by an abnormally hot summer, but the summer peak of infant mortality did not reach the terrible percentage of the summer of 1911. Also during the autumn of 1921 the weather conditions were favorable. These favorable weather conditions prevailed elsewhere as well, so that favorable death rates for the year 1921 are to be expected also from other countries. Only for the month of December, 1921, was there a higher death rate than for the corresponding month of the previous year, which is explainable by the severe influenza epidemic. The rapid and continued decrease in the death rate, since the war, is due, for the most part, to the improvement in the food situation.

THE REDWOOD TREES OF CALIFORNIA

DR. J. B. GRANT, chairman of the board of directors of the "Save the Redwoods League," has issued a report, giving the history of the league which was organized four years ago. The report, according to the *New York Times*, states that the original redwood belt is a remnant of the massive forests of this and related species that in prehistoric times covered a considerable part of the northern hemisphere. It averages twenty miles in width and extends some 450 miles from Monterey County, California, to just above the Oregon line. In the southern part of this belt, in Santa Cruz County, as long ago as 1905, the State of California established a state park, preserving what is known as Big Basin, containing many magnificent trees. Muir Woods, on the slopes of Mount Tamalpais, has already been made a national monument. And now, as a part of the Save the Redwoods movement, the nucleus of another state park has been preserved in the northern portion of the redwood belt, in Humboldt County, in the basin of the south fork of the Eel River and adjoining the California State Highway.

The Humboldt State Redwood Park, which is the beginning of a larger area to be preserved, consists of about 2,000 acres, extending fourteen miles along the California state highway, where it skirts the eastern bank of the south fork of the Eel River, between Phillipsville and Dyerville. It contains perhaps 200,000,000 feet of some of the finest redwoods. It is 230 miles from San Francisco on the main state highway leading to Eureka, California, and is administered for the state by the California State Forestry Board. It is accessible through the year by train.

One tract of redwoods saved by private donation was Bolling Memorial Grove, which is within Humboldt State Park. It was established by Dr. John C. Phillips, of Massachusetts, in memory of Colonel Raynal C. Bolling, one of the first American officers of high rank to give his life in the World War.

The establishment of Humboldt State Redwood Park is a part of the general movement to save representative groves through the redwood belt, particularly those along the "Highway of the Giants," the state highway, leading from the southernmost redwoods in Monterey to the northernmost at the Oregon line. It is in the northern region that a larger national

park, preserving adequately for all time a representative redwood forest in its primitive state, will probably be established. The task of the Save the Redwoods League is to cooperate with the state in assuring the preservation of the Highway of the Giants and to aid the federal government toward establishing the national park.

The league is interested also in promoting the preservation and reforestation of cutover redwood lands. The redwood is a tree that reproduces by sprouting from the stump, and in time produces beautiful second growth trees. While these are in no way comparable in size or grandeur with the ancient redwoods that have taken 1,000 to 1,500 years to mature, nevertheless if it is possible to save the finest of the virgin stands of redwoods, the remaining redwood area will ultimately be covered with attractive second growth.

Since the league can not hope to raise more than a fraction of the needed sum through state appropriation or private contributions, it advocates federal action toward the establishment of such a park.

CERAMIC DAY

The American Ceramic Society has issued the following letter to members of the society:

Our society has provided the program for one of the days during the exposition week (11-16 inclusive) known as Ceramic Day. This will be on Friday, September 15.

President Frank H. Riddle will appear on the opening program of the exposition with the presidents of other technical societies.

Messrs. E. P. Poste and Ross C. Purdy will appear on the special program on "Specifications." Mr. Poste will discuss specifications for enameled chemical ware and Mr. Purdy will describe the problems in writing specifications for refractories.

The partial program for Ceramic Day, September 15 is:

High temperature cements, by W. H. GAYLORD, JR., Quigley Furnace Specialties Company.

Application of magnetic separator in ceramic industries, by E. S. HIRSCHBERG, Dings Magnetic Separator Company.

Preparation of clays and minerals for ceramic purposes, by J. D. DICKEY, chemist, Industrial Filteration Corporation.

Apparatus for quickly determining fineness of grind, by ERIC TURNER, Trenton Flint and Spar Company.

Feldspar Colloquium: W. H. LANDERS, GEORGE M. DARBY, O. O. BOWMAN, 2d, V. A. STAUDT, C. R. MOORE, C. M. FRANZHEIM and others.

Manufacture of gray enameled ware, by H. C. ARNOLD.

Whiting for ceramic uses, by A. E. WILLIAMS.

Gas producers for glass works, by C. B. CHAPMAN, Chapman Engineering Company.

Witchery of glazes, by PAUL E. COX.

Architectural faience and its artistic possibilities, by CONRAD DRESSLER.

Organization of a decorative ceramic research department; financial and manufacturing considerations, by FREDERICK H. RHEAD.

R. D. LANDRUM
Chairman of Committee on Program.

THE GEOLOGICAL SOCIETY OF AMERICA

AT the last annual meeting of the Geological Society of America held at Amherst, the fellows listened to an instructive symposium on Isostasy, in which it was clearly brought out that this is not the primary cause in the making of folded mountains. There is a greater antecedent cause, and it is the later adjustments in the mountains that are due to isostasy.

It is therefore proposed that at the meeting of the society to be held at the University of Michigan next December, there be held a symposium on "The Structure and History of Mountains and the Causes for their Development," dealing with the following questions: What are the chief internal structures of mountains? To what extent is lateral compression responsible for folding and uplift? What causes the lithosphere locally to upheave and to fold into mountains? These discussions will be led by

Charles Schuchert—The sites and nature of the American geosynclines.

Chester R. Longwell—Professor Kober's theory of mountain structure and mountain making.

William H. Hobbs—The Asiatic arcs.

Arthur Keith—The Appalachians.

Jay B. Woodworth—The mountains of New England and the Maritime Provinces of Canada.

Willis T. Lee—The Front Ranges of Colorado and New Mexico.

G. R. Mansfield—The Rocky Mountains of Idaho and Montana.

Bailey Willis—The Pacific mountains.

Edmund Otis Hovey
Secretary.

THE JOURNAL OF PHYSICAL CHEMISTRY

As a result of action by the council the *Journal of Physical Chemistry* is to be published under the auspices of three great English-speaking chemical societies—the American Chemical Society, the Chemical Society at London and Faraday Society of Great Britain. Action by the Council of the American Chemical Society at the Pittsburgh meeting completed plans for this step, which is hailed by leading chemists as a fine recognition by the two conservative British groups of the high quality of the work of American chemists, and an important advance in the science of chemistry.

The action is the result of the recent visit of Dr. Charles L. Parsons, secretary of the American Chemical Society, to England, where he had a conference with officials of the Chemical Society of London in regard to the internationalization of this journel, of which professor Wilder D. Bancroft of Cornell University is editor.

The following conditions were agreed to:

1. In future the *Journal of Physical Chemistry* shall be under the joint auspices of the American Chemical Society and the Chemical Society,[1] neither society, however, being financially liable in any way.

2. The control of the *Journal* shall be exercised by a board, consisting of eight members, four being nominated by the American Chemical Society and four by the Chemical Society. These members to be appointed for a term of two years, except that one half shall go off each year, those who retire the first year to be determined by lot. No member of the board shall serve continuously more than four years.

3. The eight members of the board will elect an editor-in-chief, who shall have an equal voice on the board, except on the question of election of the editor-in-chief, on which matter he shall not vote.

4. The lines on which the *Journal* will be run shall be left entirely in the hands of the said board.

5. It is suggested that the board shall appoint also a managing editor, who shall be responsible to the board for the business management of the *Journal*.

6. The board shall report annually to each of the societies under the auspices of which the *Journal* is published.

7. The *Journal* shall be offered to members of the American Chemical Society and to fellows of the Chemical Society at reduced subscription rates.

[1] Later the Faraday Society became one of the parties of the agreement and will appoint one member of the board of editors.

Dr. Parsons also reported to the council that Francis P. Garvan, president of the Chemical Foundation, had guaranteed $10,000 annually for five years for publication work. "This guarantee I make on behalf of the Chemical Foundation," Mr. Garvan wrote, "but if the funds of the Chemical Foundation prove inadequate, I will make good the guarantee personally."

CHEMICAL PRIZE ESTABLISHED BY THE ALLIED CHEMICAL AND DYE CORPORATION

A prize of $25,000 to be awarded annually to a chemist in the United States for contributions to chemistry was announced by the Allied Chemical and Dye Corporation of New York, in a letter read by Dr. Edgar F. Smith, president of the American Chemical Society, at a council meeting which opened the sixty-fourth annual meeting of the society at Pittsburgh on September 6. The letter from Dr. Wm. H. Nichols, chairman of the corporation, is as follows:

Confirming our interview yesterday, it gives me great pleasure to state that the Allied Chemical and Dye Corporation desires to institute an annual prize of $25,000 to reward the chemist residing in the United States, who in the opinion of a properly constituted jury has contributed most to the benefit of the science and of the world. Realizing, as we do, the enormous influence which chemists working in all the fields of that science will have on the welfare of the world, we desire by this prize to so encourage the workers that even larger benefits should accrue than

those which have already placed the world under such a debt of gratitude to the profession.

We desire that you should make this announcement at such time and place as you shall deem best, and to take such steps as may be necessary to carry the matter into effect beginning with the year 1923. We assume that a committee, of which you will be chairman, will be appointed by you to consider and suggest the rules governing the selection each year of the chemist who is deemed most worthy.

We also assume that this committee would provide for the appointment of a jury to decide annually who should be the recipient. We would be glad if the committee would arrange the selection of this jury so that this company would have the appointment of two members, it being understood that neither of those members should be connected with the company.

We do not desire to limit the gift to any particular field of chemistry, recognizing as we do the importance of them all.

As the American Chemical Society is by far the largest organization of chemists, and represents every field of the science in its membership, we have thought it better to work through that society, although not limiting the gift to its members. Our sole desire is to encourage chemists everywhere in our country to do even more than they have been doing for the general good.

We have not gone into details, as we value greatly the opinions of those who would naturally be asked to serve on the committee, and do not desire to trammel them in their deliberations.

MEMBERS OF THE AMERICAN MEDICAL ASSOCIATION AND THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Members of the American Medical Association who are not now members of the American Association for the Advancement of Science have been invited to become members without the payment of the usual five-dollar entrance fee. This special invitation has been voted by the executive committee of the American Association for the Advancement of Science because of the fact that it is practically impossible for the permanent secretary's office to send an individual invitation offering this privilege to each new member of the American Medical Association each year, as is done in the case of the other scientific societies affiliated with the American Association for the Advancement of Science.

Members of the American Medical Association who are interested in this invitation are requested to write to the permanent secretary's office, Smithsonian Institution Building, Washington, D. C. They will thus secure a special invitation and a booklet of information regarding the American Association for the Advancement of Science.

BURTON E. LIVINGSTON
Permanent Secretary.

SCIENTIFIC NOTES AND NEWS

THE Association of German Scientific Men and Physicians holds its hundredth meeting at Leipzig from September 18 to 24. One of the public addresses is by Professor Albert Einstein.

THE Swiss Scientific Society held its one hundred and third annual meeting at Berne from August 24 to 27. According to the program as quoted in *Nature*, the general addresses included the following: "The trend of modern physics," Dr. C. E. Buye (Geneva); "The nature of the so-called general neuroses," Professor Sahli (Berne); "The Aar Massif—an example of Alpine granitic instrusion," Dr. E. Hugi (Berne); "The natural form of substances as a physical problem," Dr. V. Kohlschütter (Berne); "Experimental genetics in regard to the law of variation" (illustrated by lantern slides), Dr. A. Pictet (Geneva); and "Investigations into the physiology of Alpine plants," Dr. G. Senn (Bale).

AT the Pittsburgh meeting of the American Chemical Society Dr. C. L. Parsons was unanimously reelected secretary of the society. The editors of the society's journals were unanimously reelected, namely: *Chemical Abstracts:* E. J. Crane. *Journal of the American Chemical Society:* A. B. Lamb. *Industrial and Engineering Chemistry:* H. E. Howe. Dr. W. A. Noyes was elected editor of *Scientific Monographs.* The advisory committee named H. E. Howe as successor to Dr. Johnson, who resigned as editor of *Technologic Monographs.*

SIR CHARLES SCOTT SHERRINGTON, president of the Royal Society and of the British Asso-

ciation for the Advancement of Science, Waynflete professor of physiology at Oxford University, has accepted an invitation to attend the formal opening of the new biological building of McGill University in October.

PROFESSOR F. G. COKER has been presented with the Howard N. Potts gold medal of the Franklin Institute of Philadelphia, awarded to him in recognition of his recent work on photo polarimetry. The presentation was made at a dinner at the Savoy Hotel by Dr. R. B. Owens, secretary of the institute.

J. W. GREGG, head of the division of landscape gardening in the College of Agriculture, University of California, has been elected as fellow of the Royal Horticultural Society of England.

F. B. TOUGH, United States supervisor of oil and gas operations on leased public lands, has been appointed chief petroleum technologist of the Bureau of Mines, to succeed A. W. Ambrose, who has been appointed assistant director of the bureau.

MR. ERNEST A. SMITH has resigned his position as secretary of the British Non-Ferrous Metals Research Association and accepted an appointment as research metallurgist to the Sheffield Smelting Company.

G. E. SANDERS is returning to Canada this month, to take charge of the manufacture of insecticides and fungicides for the Deoro Chemical Company. For the past year he has been with the Dosch Chemical Company at Louisville, Ky.

DR. A. P. SAUNDERS, professor of chemistry since 1901 and dean of Hamilton College since 1909, has been given a year's leave of absence and will travel in Europe with his family during the coming winter. His address is care of Morgan, Harjes & Co., Place Vendôme, Paris.

WE learn from *Nature* that Professor J. W. Gregory, of Glasgow University, reports his safe arrival at Talifu, Yunnan, after a successful journey in Tibet. Professor Gregory and his son, Mr. C. J. Gregory, left England for Rangoon at the end of March last with the object of investigating some features in the mountain structure of northwestern Yunnan and western Szechuan.

ROBERT T. AITKEN has returned from about two years spent in Tahiti and various islands of the Society and Austral groups. His work is to supplement the investigations of the Bayard Dominick Expedition, which is making an intensive study of Polynesian origin and migration. Mr. Aitken collected material objects illustrative of the life of the present-day people, and a few that date back to the early inhabitants of these islands. He also brought back a few folk tales in fragmentary form, physical measurements of the inhabitants and photographs of the majority of the people of the island of Tubuai in the Austral group.

THE American Society of Mechanical Engineers has appointed a committee to report on a standard smoke ordinance to apply to all cities of the country. It consists of O. P. Hood, chief mechanical engineer of the United States Bureau of Mines as chairman, Henry Kreisinger, P. J. Dougherty, Lloyd R. Stowe, Everett L. Aillard and Osborn Monnett.

DR. WILLIAM S. HALSTED, since 1889 professor of surgery in the Johns Hopkins Medical School, died in Baltimore on September 7, aged seventy years.

DR. HAROLD C. ERNST, professor of bacteriology in the Harvard Medical School from 1891 to 1921, and editor of the *Journal of Medical Research,* died on September 7, aged sixty-six years.

DR. EDWARD ANTHONY SPITZKA, specialist in the anatomy of the brain, died at Mount Vernon, N. Y., on September 4, at the age of forty-six years.

ALEXANDER RIGHTER CRAIG, secretary of the American Medical Association since 1911, died on September 2, aged fifty-four years.

W. H. HUDSON, the distinguished English ornithologist and writer on natural history, died in London on August 18 in his eighty-first year.

THE Brigham Young University, of Provo, Utah, has just closed its first annual Alpine summer school. The school was housed in tents

at a point about 7,500 feet above sea level at the base of Mt. Timpanogos with an elevation of 12,000 feet. Courses were offered in botany and geology.

THE Rockefeller Foundation, through Dr. Platt W. Covington, state director of the International Health Board of the Foundation, has agreed to donate the sum of $5,000 yearly for three years toward establishing a laboratory in San Bernardino County, California, for research work. A condition is made that the county provide a like sum for the three-year period and furnish the laboratory and an experienced physician and chemist to be placed in charge of the work. San Bernardino is one of three counties in the state to receive the offer. The object of the proposal is to better health conditions and provide means for lowering the heavy death rate.

AN effort is being made in England to raise $100,000 for the construction of an airship to fly to the North Pole. Captain Charles Frobisher, formerly a war pilot, is the leader. His idea is to start with an airship from London and fly by way of Christiana and North Cape and Bear Island to Spitzbergen, where the airship would be overhauled for the final 700-mile dash. His estimate is that it would not be necessary for the ship to attain a speed of more than fifty miles an hour in order to reach the goal, and that a crew of ten and supplies could be easily carried. Another advantage of the airship over the airplane is the proposed installation of a powerful wireless in order to maintain communication with the outside world.

DURING October the following public lectures will be given at the Brooklyn Botanic Garden:

October 7—"A Garden Pilgrimage in England": Mr. Montague Free, horticulturist, Brooklyn Botanic Garden.

October 14—"The Origin of Cultivated Plants": Dr. Orlando E. White, curator of plant breeding, Brooklyn Botanic Garden.

October 21—"Four Seasons in the Garden": Mr. Leonard Barron, editor of *The Garden Magazine*, Garden City, L. I.

October 28—"Health and Disease in Plants": Dr. Arthur Harmount Graves, curator of public instruction, Brooklyn Botanic Garden.

ACCORDING to a dispatch to the London *Times*, the opinion was expressed at the meeting of the Association of Tropical Medicine, which is holding its conference at Hamburg, attended by scientists from Holland, Java, Turkey, South America and Germany, that Germany has made a discovery of considerable importance. "Beyer 205," the discovery of the Bayerische Farbwerke, is said to be a cure for sleeping sickness, both for human beings and animals. This drug kills the microbe causing sleeping sickness in man and animals without injuring the patient. The Bayerische Farbwerke has supplied the Belgian colonial minister, on his request, with a quantity of "205" for research purposes to be used in the laboratories at Leopoldsville in the Congo, and the Belgian technical schools for tropical diseases. German scientists expect, owing to the latest development, that this discovery will point the way to a cure for malaria and also coast fever in animals.

A REPORT was presented to the French Academy of Sciences on August 21 which gave the results of an examination by Professor Louis Boutan, of Bordeaux, of a "cultivated" pearl made by Mr. Mikimoto's method. Professor Boutan's conclusion is that the Mikimoto pearls are apparently identical with natural ones. M. Boutan says that the apparatus, by means of which MM. Galibourg and Rysiger disclose the artificial nucleus which is to be found in the ordinary cultivated pearls, is of no use in distinguishing those of the Mikimoto variety, as these have no nucleus. M. Louis Joubin, who presented the report to the academy, made the interesting point that as the "culture" process is applied to oysters which produce pearls spontaneously, Mr. Mikimoto himself can never be sure that his "cultivated" pearl is not an ordinary natural one. One effect of the report would appear to be that the authenticity of "real" pearls now depends entirely on the word of the man who sells them.

UNIVERSITY AND EDUCATIONAL NOTES

THE will of the late Frederick Bertuch bequeathes, to take effect on the death of Mrs.

Bertuch, $750,000 to public purposes. Among these bequests are $100,000 to Columbia University for poor students and $50,000 to Cooper Union.

THE *Journal* of the American Medical Association reports that the Medical School of the University of Rochester is making progress. A research laboratory will be completed in about three months. An affiliation is being brought about between the city authorities and the university for the building of a municipal hospital on or near the university campus, and, in accordance with the arrangements, the university medical school will furnish the professional training and nursing staffs, and the medical teaching will be carried on in the hospital. Walter R. Bloor, Ph.D., of the University of California Medical School, has accepted the chair of biochemistry, and will begin his work this fall. Dr. George W. Corner, now at Johns Hopkins University, is to be the professor of anatomy. He will assume his duties at Rochester early in 1924. Dr. Nathaniel W. Faxon, now of the Massachusetts General Hospital, will assume the position of director of the University Hospital on October 15. The school will be ready to receive students in the fall of 1924 or 1925.

DR. RICHARD M. SMITH, instructor in pediatrics, Medical School of Harvard University, has been appointed assistant professor of child hygiene in the new school of public health.

DR. CHARLES P. ALEXANDER, of the Illinois Natural History Survey, has been elected assistant professor of entomology at the Massachusetts Agricultural College, to fill the vacancy caused by the resignation of Dr. W. S. Regan last autumn.

DR. ALEX. MCTAGGART, formerly agriculturist of the Department of Agriculture Museum at Wellington, New Zealand, has been appointed assistant professor of agronomy at Macdonald College, Canada. He will be in charge of plant breeding work, with special reference to grasses and clovers.

DR. J. W. MCLEOD, lecturer in bacteriology at the University of Leeds, has been appointed the first occupant of the Sir Edward Brotherton chair of bacteriology in that university.

DISCUSSION AND CORRESPONDENCE

THE ZODIACAL LIGHT

THE most brilliant display of the zodiacal light that I have observed occurred on the night of April 8, 1922. My point of observation was Poulan, Worth County, Georgia (latitude 31-30 north; longitude 83-45 west). The light covered more of the heavens than shown as a zone of zodiacal light in any of the several hundred charts made of it by an observer with Commodore Perry's expedition to Japan in 1853-1856, and printed in a huge tomed report by the United States government as a part of the reports of that historic occurrence. One great volume of the Perry reports is given over entirely to the zodiacal light, forming the most massive single piece of literature upon the subject. I have observed the zodiacal light from the Straits of Magellan to 46 north latitude without having seen such a display as the one here alluded to. It dulled the near full moon. There was not a cloud in the sky. In the brilliant moonlight the zodiacal light made the spots in the heavens unilluminated by it looks like coal sacks, so great was the contrast. I have seen the aurora borealis above the Arctic circle and the aurora australis below the Antarctic line, and seldom were these exhibitions more brilliant and effective than the display that was neither on the night of April 8 last. It must be true that observers in southern latitudes are often confused by the zodiacal light and take it for an auroral burst. The zodiacal light is usually most noticeable in the western sky. This one covered more than half the heavens irregularly. It continued from 9 P.M. until 3 A.M. with varying brilliancy. Judge Roberts P. Hudson, of Sault Ste. Marie, Michigan, was my companion observer on the night of April 8.

CHASE S. OSBORN

SAULT STE. MARIE, MICHIGAN

THE MEALY-BUG CALLED PSEUDOCOCCUS BROMELIÆ, AND OTHER COCCIDS

IN my recent review of Wheeler on *Tachigalia* insects, I gave a footnote questioning the validity of the name *Pseudococcus bromeliæ* (Bouché), as applied to the species of mealy-bug found on *Tachigalia*. This has brought

me a letter from Hawaii, where an insect presumed to be the same is of economic importance, asking for additional information. Since the matter is one of importance to economic entomologists, it may be worth while to state explicitly why Bouché's name can not be used. I have not seen Bouché's original work (1834), but his whole description is quoted by Signoret. In 1875 Signoret received a mealy-bug on pine-apple, which he described, saying that it was probably Bouché's *Coccus bromeliæ*. Since there was already an entirely different *Coccus bromeliæ*, published in 1778 (now called *Diaspis bromeliæ*), it appears that Bouché's name was in any case unavailable. Signoret, uninfluenced by the homonym, was still in considerable doubt as to the identity of his insect, and accordingly gave Bouché's description, so that the reader might form his own opinion. That description is somewhat confusing, but we are told that the fertilized female takes the form of a convex, short, elliptical shield, a little narrower in front. The last abdominal segment is cleft. The females, after an early stage, remain in one place all their lives, unless one tears them off. The insect is common in greenhouses, on various plants. There can, I think, be little doubt that Bouché had before him the Lecaniid *Saissetia hemisphærica* (Targioni, 1867); surely it was not a mealy-bug. In the Fernald Catalogue of Coccidæ there is confused with this *Lecanium bromeliæ* Bouché, grey marbled with brown, which Signoret did not undertake to identify. It was probably *Lecanium hesperidum* (L.).

Another coccid which seems to need discussion is the large Lecaniid of the tulip-tree. Dr. W. E. Britton (Bull. 234, Conn. Agric. Exp. Station) gives a good account of this insect, but calls it *Toumeyella liriodendri* (Gmelin), stating that it was so identified by Sanders, "after a careful study." Gmelin's *Coccus liriodendri* was based on an account by Dr. John Hill, of London, appearing in the *Hamburgisches Magazine* for 1753. Many years ago I borrowed this work from the Library of Congress, and together with Mr. Pergande went over the description. The account is very vague, and contains some apparently inaccurate statements, but it evidently applies to a Lecaniid on the tulip-tree. We concluded at the time that it was not possible to reach a definite decision, and were not in favor of displacing Cook's name *tulipiferæ* (1878). There is no indication that any one has really reconsidered this evidence, and I think the scale should stand as *Toumeyella tulipiferæ* (Cook).

Sanders (*Journ. Economic Entomology*, 1909, p. 432), adopting *Pseudococcus adonidum* (L.) as the name of the common long-tailed mealy-bug (*P. longispinus* Targ.), refers to the "good description of the insect in *Systema Naturæ*, Ed. XII." The "good description" refers to "linea dorsalis longitudinalis elevata . . . area inter lineam dosalem marginemque totidem punctis in seriem longitudinalem dispositis . . . cauda bifida," etc. Conceivably this may be *Orthezia urticæ* (L.), but this is guessing. There is not anything to clearly indicate the mealy-bug, and part of the description contradicts such a reference. I am in favor of using the oldest names when there is real evidence, or even a satisfactory presumption, in their favor, but when the descriptions are inapplicable it is another matter.

The application of the generic name *Coccus* L. to the soft scales may have to be reconsidered. The original Coccus (the word meaning a berry) was the hard round scale of the oak, commonly called *Kermes*. Under the rules, a good argument can be made for considering *Coccus ilicis* L. (*Kermes ilicis*) the type of *Coccus*, on grounds of tautonomy, but there is room for diversity of opinion. *Lecanium pulchrum* King, well redescribed by Marchal (1908), should apparently stand as *L. rufulum* (*Eulecanium alni* var. *rufulum* Ckll.).

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THE DETERMINATION OF FAT IN CREAM

TO THE EDITOR OF SCIENCE: I noticed in SCIENCE for July 7, page 25, an abstract of a paper read before the American Chemical Society by E. G. Mahin and R. H. Carr, entitled "Errors in the determination of fat in cream."

In 1910, the dairy department of Purdue University, under the direction of Professor O. F. Hunziker, head of the department, made

extensive investigations to determine if it is desirable to use any material for eliminating the upper meniscus on the neck of the Babcock testing bottles and after a very extensive experiment, came to the conclusion that for uniform and accurate results of the cream test, the meniscus must be eliminated. The reason for this conclusion was that the color of the test, clearness of fat, amount and direction of light, kind of background of the test bottle, angle from which the test is read, etc., gives a varying meniscus.

A number of experiments were tried out at this station as well as at other experiment stations about this time with different liquids for eliminating the meniscus. Amylalcohol was one of the materials experimented with at this time, but it was found that its fat dissolving properties and the harmful effect of the vapor on the operator made it impracticable for commercial use.

Glymol, which is a white mineral oil, was found not to have the objection of the amylalcohol and at the same time eliminated the meniscus which made an accurate test so difficult. The use of glymol is now being used in practically every state of the Union and its value has been thoroughly proved. The authors of the above mentioned article, while they condemn the use of glymol, make the following statement, "If the latter is added slowly and carefully, little or no error occurs." This kind of criticism may be made of any test, but from our inspection of over 1,800 cream buying stations in Indiana, this last year, in our Creamery License Division, we have found at least 98 per cent. of the testers adding the glymol as it should be added and where the testers fail to comply with the creamery and testers' license law or perform tests that are inaccurate, their license is revoked. In cases where licenses were revoked this last year, our investigations show very conclusively that the incorrect testing was due to intent in practically every case, rather than by faulty methods of testing. In the last sentence of this article, the authors say: "It is conclusively shown that the methods (referring to the use of glymol) is not safe in the hands of the average dairy testers, but the use of amylalcohol for this purpose, substituted for hydrocarbon oils, gives reliable results in all cases." A few tests are sufficient to show that this statement is erroneous. Six samples of cream were used and the test read by adding amylalcohol. The tests were read as soon as the amylalcohol was placed on the test and the six tests averaged 22.2 per cent. After standing ten minutes, the six tests averaged 21.5 per cent, showing very conclusively that the amylalcohol dissolves a portion of the fat and does not give reliable results.

As chairman of the Creamery License Division Board of Indiana, a board which has for its purpose the enforcement of the Indiana testers' license law and the protection of the producer against fraudulent or incorrect tests of milk and cream, I am very anxious to receive all constructive criticisms of our present methods of testing, but under our present methods of checking the cream buying stations in Indiana, it is a most erroneous statement to intimate that ten large creameries in Indiana are beating the producers out of $20,000 worth of cream per year, and any one who is connected with the business and knows conditions in the state would not make such a statement, for it would be impossible under the Indiana creamery and testers' license law. The statements which the investigators have made in the article referred to are not only incorrect truths, but the damage which may result from the distribution of such an article is unlimited.

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DR. LIPMANN'S LABORATORY OF APPLIED PSYCHOLOGY

LETTERS from Dr. Otto Lipmann, of Berlin, state that he is confronted with the necessity of giving up his scientific work unless he finds funds which will allow him to keep on with his laboratory of applied psychology. From the Emergency Society for German and Austrian Science and Art, I have received word that $200 will be voted by it provided that American psychologists will pledge an equal amount. A similar arrangement has been carried out by groups in two other fields.

At the suggestion of President Knight Dun-

lap, of the American Psychological Association, I am offering to receive and be responsible for contributions. The fund will be used for continuing Dr. Lipmann in his chosen work. Quick response promises to prevent the loss of an international leader from the field of scientific research.

Dr. Lipmann's assistance in founding and editing the *Zeitschrift für angewandte Psychologie* and its *Beihefte;* his important contributions to educational and vocational psychology, 34 titles in one recent bibliography in applied psychology; and the prospect of his many years of continued work, should rouse us out of our routine contributions. There is hope of state support for his work if he can be helped past the present depression. A recent letter makes clear that the need is pressing if he is to keep to his calling.

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SHIPMENT OF AMERICAN SCIENTIFIC LITERATURE TO RUSSIA

THE American Committee to Aid Russian Scientists with Scientific Literature was informed by the Headquarters of the American Relief Administration in New York that the first shipment of eleven cases, each weighing about 350 lbs., is being forwarded on the S. S. Norlina, scheduled to sail about August 15th.

The response of American scientific institutions and departments to the appeal of the Committee was remarkably generous. In handling these first shipments the American Relief Administration had considerable difficulty in following the original plan, chiefly due to the fact that many of the donors failed to prepay the charges to New York and to send advices and lists of their publications, making it necessary for the American Relief Administration in New York to make up lists from the books and pamphlets as the packages were opened. The Committee would greatly appreciate it if the donors of scientific literature for Russia would in the future enclose at least six copies of the list of publications contributed by them. This number of copies is absolutely essential in order to furnish the offices of the American Relief Administration abroad with copies of the packing lists, one to be enclosed in each case, one sent to the American Committee in Washington, still another retained in the files in New York. One copy with a special column provided on it is to be sent to Moscow and later returned to the American Committee with the record of the disposition made of each package of literature sent. All future shipments should be consigned *care Gertzen & Co., 70 West Street, New York, N. Y.*

The literature contributed by donors for delivery to specific institutions or individuals was packed without being opened and the Committee in Moscow was requested to make delivery to the person or persons designated on the package. The copy of the inventory, when it is returned from Moscow, should therefore indicate the extent to which it was practicable and consistent with our agreements to comply with the wishes of the donors.

RAPHAEL ZON,
Secretary

QUOTATIONS

CHILDREN AND MUSEUMS

THE direct educational work accomplished by museums in the United States is a perpetual source of shame to us in this country. We are well aware that much is being done in some of our own museums, often at the self-sacrifice of their officials; but have we anything to compare with what is described in a recent number of *Natural History* (March-April, 1922)—the journal of the American Museum of Natural History? Consider lantern-slides, for example. Our own Natural History Museum has recently started one or two loan collections, comprising in all some few dozen slides. Those of the American Museum number many thousands. They are stored in a room accessible to teachers, who can thus select precisely what they want for their class-room lectures. Last year more than two hundred thousand slides were circulated. It is not long since a fair collection of slides made by an assistant in our own museum was handed over to another institution because there were no facilities for keeping it in the museum itself. Needless to say, the American Museum has a lecture theater. It has 869 nature-study collec-

tions to be lent to any public school in greater New York. There are two motor cars and a motor cycle to deliver slides and collections. Each messenger visits from twenty to forty schools a day. The American Museum is about to erect a special School Service building of five stories where from three to five thousand children daily may be taken care of properly. The blind are also provided for.

Of course, all this can not be done by the ordinary officers of the museum, and that is a fact which must be recognized in this country. The American Museum has its own department of education, with Mr. George H. Sherwood at the head. In the same way the Brooklyn Botanical Garden has its curator of elementary education, who contributes to the same issue of *Natural History* an interesting article on "Gardening and the City Child." But the work which starts in the museums and public gardens of New York and Brooklyn is taken up by other outside bodies, as the School Nature League of New York City, the president of which, Mrs. John I. Northrop, here tells us how in one of the elementary schools in the middle of the slums a wonderful nature-room has been installed. It is visited by from eight hundred to one thousand children every week. Here is a place for all those miscellaneous curiosities so frequently rejected by the staid museums. They can be placed in the hands of the children and many a fascinating lesson drawn from them. The love of nature thus begun is carried out into the open by means of summer camps, and so becomes linked up with the Boy Scout camps with their traveling museums.

Well, why is it that the Americans have got so far ahead of us on these lines? They have no doubt a new field to cultivate, and they do not have to contend against the terrible weight of inertia inevitable to some of our royal and ancient establishments. But to a large extent it is because Americans are not ashamed of having an ideal and of talking about it. They do not mind saying what they are going to do, and they make the utmost of everything that they have done. This is not the Englishman's way, but it is a way that interests the public both rich and poor. It brings money from the former and enthusiasm from the latter. If we want to achieve the same results we must not be above following somewhat similar methods. Here, during the summer holidays, are the children crowding our museums at South Kensington day after day. Can not something more be done for them, even if we shed a little dignity in the process?—*Nature.*

SCIENTIFIC BOOKS

The Coccidæ of Ceylon. By E. ERNEST GREEN. London: Dulau and Co., 1896-1922. Pp. xli plus 472; 209 plates.

Part I of "The Coccidæ of Ceylon" appeared in 1896, Part II in 1899, Part III in 1904, Part IV in 1909, and with the appearance of Part V there is completed a work that is worthy of a place among the classics of entomology.

The Coccidæ or scale insects are a group of almost unsurpassed economic importance. There is probably no horticulturist who is not familiar with at least a few of the species and whose pocketbook is not the lighter as a result of their activities. The cost of repressing them is a constant tax upon the horticultural industries everywhere, a part, in effect, of the overhead expense of producing horticultural products. And the ease with which they are transmitted from one part of the world to another has resulted in the practically cosmopolitan distribution of many of the most harmful species together with the frequent introduction into new regions of others.

So it is that the scale insects stand in need of the most careful systematic study. But the minute size of many of the species, the difficulty of obtaining adequate microscopic preparations, and the obscureness of the structures available for classification have always stood in the way of such study. Unfortunately these difficulties have been only too completely reflected in the quality of the systematic work that has been done upon the family. The systematic work upon this group is in general of by no means very satisfactory character and is in large part sadly deficient. Yet to this generalization "The Coccidæ of Ceylon" is a most

gratifying exception. It stands, indeed, at the very apex of all the work that has been done upon the Coccidæ.

It is not that "The Coccidæ of Ceylon" is entirely free from defects. The fact that its preparation has extended over more than a quarter of a century precludes this, for since it was begun there have been radical changes in our methods and in our standards as well. Yet throughout it has always stood fully abreast and even in advance of the best contemporaneous work. Above all, the student, turning to its pages, can identify with relative certainty the species with which he may be dealing. With this much rendered possible, criticisms of any other features are but secondary. It is a splendid work, beautifully illustrated, well arranged and well printed. To its author all entomologists, whether economic or not, who are interested in the scale insects are under an obligation that can but illy be repaid. For the work has been a labor of love, its author's recompense the pleasure in its accomplishment.

With technical criticisms, of which there are some, I am not here concerned. Nor is it necessary to deal with the scope of the work, for practically all entomologists are familiar with this from the earlier parts. It is my desire simply to call attention to the appearance of the final part and to congratulate the author upon the completion of a huge task well done. Its completion clinches his hold upon a position that has really long been his, that of the foremost student of the Coccidæ.

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SPECIAL ARTICLES

PHOTOPERIODISM OF WHEAT: A DETERMINING FACTOR IN ACCLIMATIZATION

GARNER and Allard (4), working with several species of plants, found that normally a plant could attain the flowering and fruiting stage only when the length of day was favorable, and suggest the terms *photoperiod* and *photoperiodism* to designate the favorable length of day and the response of a plant to the relative length of day and night. They conclude that, varying with species and variety, there is a critical photoperiod essential for the initiation of the fruiting stage of each plant, and that when this critical photoperiod does not occur the plant tends to remain vegetative.

In a preliminary experiment, the writer has found that a proper adjustment of the daily exposure to light, independently of temperature, will control the type of growth in the winter wheat plant and that by regulation of this factor it is possible to induce the jointing and the heading stages irrespective of season. In addition, this experiment has shown that there is a minimum stimulating photoperiod for the control of each of these stages of growth in the winter wheat plant, that for the succeeding stage not being the same as that for the preceding, and each photoperiod being, therefore, within certain limits critical for the stage concerned.

Although factors governing habits of growth, the distribution and the production of wheat have been the subject of many studies, the literature available has not revealed that any have ever considered, beyond the generalizations of Garner and Allard, the factors of photoperiodism as having a deciding influence. Circumstantial evidence, however, is available, which on analysis clearly indicates that these factors are important both with winter and with spring wheats. Grantham (5), Jardine (6) and Seivers and Holtz (11) have shown the tendency of winter wheat to a vegetative type of fall growth and have emphasized that the amount of this growth is dependent on time of seeding and available fertility. Gaines (10) and Neilson-Ehle (7) have found, in certain localities of the north temperate zone, the winter character to be inheritable as a simple Mendelian major. The northern limits of the winter wheat belt in the United States bear a significant relation to the northern limits of an active growing season of 150 days (1, 2). Smith, Root and Blair (3, 8, 12, 13, 14), in statistical studies of data from Ohio, found the dominant weather factor for winter wheat difficult to determine, but all agreed that the month of March was the critical period during which the effects of snowfall and temperature were later most reflected in condition and finally

in yields of winter wheat. Apparently, from their studies, the influences controlling the beginning of the development which determined final yielding ability of winter wheat occurred in March, regardless of how favorable growing conditions were for the rest of the season or how severe conditions during the preceding dormant period had been. Schafer and his associates report (9) that Hybrid 128 will not head out when planted later than March 11, and (10) that Turkey Red will joint in October when planted in April, while Hybrid 128 will not. McCall and Wanser (15) have found that Jones Fife and similar wheats joint early in the spring, while wheats of the Turkey Red type do not joint until a later date.

These observations indicate that the winter habit of wheat is caused by the absence of the critical stimulus which is essential for the initiation of the jointing stage. Though the response to the stimulus may be affected and altered by temperature and nutritional factors and, under field conditions, apparently, has been usually associated with these factors, the stimulus itself is, nevertheless, independent of them and for any given locality is controlled more by date than by current growing conditions. The observations of Schafer and his associates and of McCall and Wanser indicate that the date of the occurrence of the stimulus varies for different varieties, but for any given variety is fairly constant in a given locality.

In the light of the work of Garner and Allard and of the results secured by the writer, all of this evidence indicates, in the case of winter wheat, the stimulus for jointing to be a critical photoperiod having a maximum limit. The passing of this maximum limit results in a spring-sown winter variety failing to joint until the occurrence of shorter days during the following fall or succeeding spring. The season at which jointing then takes place depends on the occurrence of the length of day corresponding to the necessary photoperiod and an accompaniment of temperatures favorable for growth. In any case, heading, which must be preceded by jointing, is delayed until the following summer because of the longer day necessary to start this stage of development.

Although a preliminary experiment is always restricted in scope, the close agreement between the results of this experiment and the analysis of the supporting evidence makes possible a few safe tentative conclusions. The development of winter wheat requires a critical photoperiod for jointing and also a separate and distinct critical photoperiod for heading. Garner and Allard, working with dicotyledonous plants, mention but one critical photoperiod. Although varying with species and variety in the intensity of distinction, there probably are for most monocotyledonous and some dicotyledonous plants at least two critical photoperiods, one for starting culm or stalk development from the tillering or rosette stage and another for starting the heading or budding and blossoming stage.[1] The photoperiods for both responses probably have an optimum with a maximum and a minimum limit, but for winter wheat they are independent of each other, do not overlap and vary with variety. The northern limits of the distribution of winter wheat are probably very largely controlled by the relation of the date of the beginning of the active growing season to the date at which the longest day within the limits of the critical photoperiod for jointing occurs in that locality.

While the photoperiods for jointing and heading do not overlap and are entirely distinct in the case of winter wheat, they are not so distinct in the case of spring wheats. In the latter group the photoperiod for jointing is of greater magnitude than in the former, possibly without a maximum limit, and jointing and heading are possible under more nearly an identical photoperiodic stimulus. As a result such varieties when sown in the spring joint and head the same season. Photoperiodism, therefore, is the key to the distinction between winter and spring wheats.

Although no published evidence showing the effects of photoperiodism in the development of spring wheat is here referred to, there is, nevertheless, an abundance of available material, some of which will be mentioned in a later detailed report of experimental work now in

[1] In an article published in SCIENCE (June 2, 1922) since the preparation of this paper Garner and Allard recognize the two photoperiods for dicotyledonous plants but do not mention or consider monocotyledonous plants.

progress. This work, an enlargement of the preliminary experiment, is intended to cover certain phases of photoperiodism as it affects varietal adaptation and drouth resistance of both winter and spring wheats.

Whatever may be the final outcome from the standpoint of direct application in practical crop production, there can be no doubt that the present studies throw an entirely new light on crop and especially varietal response in a given locality, and that a knowledge of these factors will make possible a better and more logical interpretation of investigations in both crops and soils and will as well give a more sound basis for future work in crop adaptation and breeding.

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IMPROVED METHODS IN NEAR INFRA-RED ABSORPTION STUDY

SOME twenty or more years ago Julius, Donath, Puccianti, Iklé, Coblentz and others were interested in the study of infra-red absorption in organic compounds. The apparatus they had to work with at that time made the study very tedious, and as Coblentz[1] has said, "usually after investigating half a dozen compounds the results have been given to the public" by the investigator. Using the electric arc, Nernst lamps and Zircon burners as sources of radiation, rock salt or quartz prisms for dispersion, and bolometers and radiometers for the detection of the radiation, these men succeeded in studying the absorption spectra of a great many organic compounds even far out into the infra-red. In fact, the biggest part of the work was done in the field beyond the so-called near infra-red, that is, beyond 30,000 Å.

But with such comparatively weak and unsteady sources of radiation, small dispersion, and unsatisfactory methods for the detection of this radiation, no high degree of accuracy in the measurements of absorption bands has been claimed. During the last twenty years very little work has been done in this field. Coblentz[2] has recently published a bulletin in which he gives certain data and curves for the absorption spectra of certain organic oils, both animal

[1] W. W. Coblentz: *Astrophysical Journal*, 20, 1904.

[2] W. W. Coblentz: Scientific Paper of the Bureau of Standards, No. 418.

and vegetable oils, in the region of the near infra-red. In this paper he shows that because of the great similarity in the spectral curves of these oils, a study by means of infra-red absorption does not lead to a detection of adulteration of one oil with another.

But the region of the spectrum between the visible and 30,000 Å is filled with characteristic absorption bands in the case of organic compounds, and consequently makes a very interesting part of the spectrum to study. The writer is at present studying the absorption of many carbon compounds in this region by means of a spectro-thermograph designed by Professor E. P. Lewis of the University of California, under whose supervision this work is being done. There are certain advantageous features in the construction and use of this instrument.

The source of radiation is a 108 watt lamp made with a helix of tungsten wire for a filament. It has been found that the intensity can be increased by as much as forty per cent. by placing a concave mirror of about a ten centimeter diameter behind the lamp and focussing the rays on the slit through the lamp itself.

For dispersion two 30° flint glass prisms were used. Now flint glass gives a greater dispersion in this region than does quartz which is usually used in near infra-red work. Furthermore, it is almost as transparent as quartz, the limit of transmission for each being around 30,000 Å. The back of the second prism was silvered and the radiations caused to pass twice through each prism, thus doubling the dispersion. This gives a dispersion of between two and three times that obtainable with a single 60° quartz prism and between four and five times that obtained from a similar rock salt prism. The silvered prism was capable of rotation about the first prism so that the angle between these was equal to twice the angle of incidence necessary for minimum deviation of radiation falling upon the thermopile, which was used in series with a sensitive Leeds-Northrup galvanometer to detect the radiation. This rotation was accomplished by means of a small thumb-screw which projected through the black box which enclosed the system of mirrors and prisms. Thus it was possible to focus the eye upon the galvanometer scale and, turning the prism, make an approximate analysis of a given substance in a few minutes.

This rapidity of locating either absorption bands or emission lines proved to be very helpful in the process of calibration of the instrument. Since no indices of refraction were obtainable for the glass prisms, the instrument was calibrated by observing certain metallic emission lines and solar absorption bands determined largely by Paschen with a grating. Coblentz states that emission lines may be used in calibrating up to 10,000 Å, but it was found that the following lines could also be detected when the proper salts were introduced into the carbon arc: Tl, 13,010 Å; Na, 18,460 Å; Ca, 19,800 Å. In locating the positions of the solar absorption bands, sunlight was reflected in from the window and focussed upon the slit. As the prism was rotated the galvanometer deflection would decrease to a minimum in the neighborhood of an absorption band. By approaching from both the long and the short wave-length sides a set of quite consistent values for the corresponding dispersion could be obtained. The highest calibration point was for the solar absorption band at 25,000 Å.

It has been mentioned in the earlier literature of the subject that all compounds that have a carbon atom united directly to a hydrogen atom have characteristic absorption bands in the neighborhood of 17,000 Å. In this present work this same band is found, and two others, at about 11,500 Å and 13,800Å, appear in every compound in which there is a C-H group. Twelve compounds have already been carefully analyzed, and an approximate determination of the positions of the absorption maxima has been made for some fifteen more. There are very prominent displacements of these absorption maxima in certain compounds. In some cases these shifts are toward the shorter wave-lengths and in other cases toward the longer wave-lengths.

The mapping of the spectral curves of certain groups of compounds is being continued, and an attempt will be made to ascertain whether the shifting of absorption maxima follows any definite laws.

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